(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 795 292 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.09.1997 Bulletin 1997/38

(51) Int. Cl.[6]: A47L 15/23

(21) Application number: 96202882.5

(22) Date of filing: 16.10.1996

(84) Designated Contracting States:
DE FR IT

(30) Priority: 09.02.1996 IT MI960250

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(54) Dishwasher with rotating sprayer with selectively fed spraying nozzles and associated washing method

(57) Dishwashing machine with a spraying device (11) of the hydraulic whirler type forming two separate manifolds (17, 18), each provided with spraying nozzles (21, .. 26, 31, .. 36) which travel along separate spraying paths, the two manifolds (17, 18) being selectively fed in such a manner that the combined feeding of the two manifolds by a pump (4) makes it possible to achieve a high spraying flow rate with low-energy spraying jets and the selective feeding of only one of the two manifolds makes it possible to obtain spraying jets with high kinetic energy, although of lower cumulative flow rate: the selective feeding of one or the other collector, at different times, makes it possible to double the number of spraying paths and to obtain a variable orientation of the jets, with a washing action which is more extensive and penetrating as a result of the direct exposure to the spraying jets of the entire surface of the load to be washed, yet with a minimal volume of water in circulation.

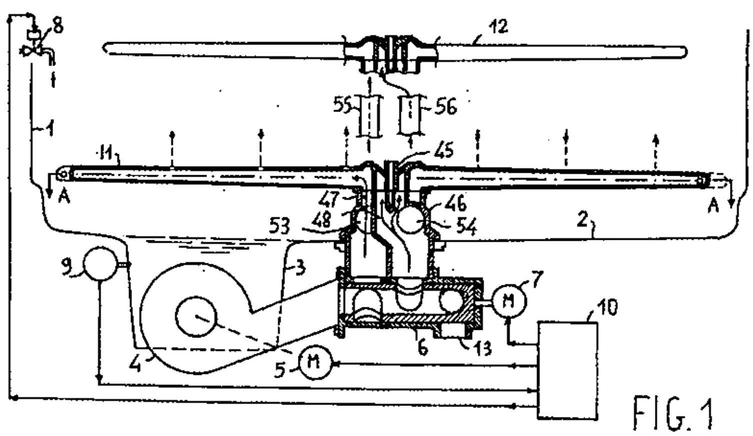

FIG. 1

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Description

The present invention relates to a dishwashing machine with at least one rotating spraying device, and preferably two, provided with selectively fed spraying nozzles, and an associated washing method.

It is known that dishwashing machines consist essentially of a washing chamber, closed at the bottom by a tank for collecting liquid, into which washing water, if appropriate decalcified, is admitted and, in appropriate phases of the washing process, expediently heated and mixed with detergent.

The washing liquid is sucked in, during the washing process, by a pump and conveyed into spraying devices, generally of the type with rotating arms arranged symmetrically relative to an axis of rotation, which, by their movement, spray, possibly with a uniform distribution of the spraying jets in the chamber, the dishes accommodated in appropriate baskets in the washing chamber.

The use of rotating arms makes it possible to achieve good washing with a minimal volume of liquid which is made to recirculate from the collecting tank into the spraying arms by a low-power pump with a small flow rate and sufficient head to impart to the spraying jets a speed and therefore kinetic energy which is adequate for washing effectiveness.

The reason for this is obvious: the power employed by the pump is, to a first approximation, for equal head H which determines the outflow speed of the jets, proportional to the cumulative flow rate of the jets and the smaller the latter is the lower the power employed is.

Moreover, the smaller the flow rate is, the more it is possible to reduce the dimensions of the pump and of the recirculation pipes, without introducing appreciable head losses, and therefore the volumetric capacity of the recirculation system, with an evident reduction in the quantity of washing liquid employed.

With this dual aim, it is a common expedient in dishwashing machines to feed alternatively, in a mutually exclusive manner, one of two rotating spraying devices, upper and lower respectively, and if appropriate to feed the two devices simultaneously, with a dividing of the flow between the two arms which is varied in time.

Recently, dishwashing machines have also been proposed, in which the pump or the pumps are actuated by variable-speed motors, for example by three-phase asynchronous motors supplied by a converter, the frequency of which can be controlled.

Since the flow rate of a centrifugal pump is to a first approximation proportional to its speed of rotation and the head is proportional to the square of the speed of rotation, it is possible to reduce the speed of rotation and the power consumed in order to reduce the kinetic energy of the jets when not required, by slightly reducing the flow rate, and to increase it when the washing operation requires greater energy of the spraying jets.

This solution leads to a certain saving in consumption but is expensive and does not solve the problem of reconciling washing effectiveness with short operation times and reduced consumption.

The washing process or cycle generally comprises different phases of prewashing, washing and rinsing, in which the washing liquid which is sprayed onto the dishes ought to have different characteristics.

In the prewashing and rinsing phases, it is necessary to remove the particles of dirt which adhere loosely to the surface of the dishes, ideally with a high liquid flow rate (to make the operation quicker) and a high speed (therefore kinetic energy) of the spraying jets is not required.

In the washing phase or phases, however, it is necessary to carry out locally a mechanical action of considerable pressure in order to bring about the detachment of the particles of dirt, which can be achieved only by a particularly high speed of the spraying jets, which jets must, during the washing phase, strike all the points of the surfaces to be washed.

From this point of view, the use of variable-speed pumps does not achieve an optimum result because a reduction in speed does involve a reduction in head but also in the flow rate, whereas an increase in the latter is desirable.

A further disadvantage of known dishwashing machines is that the rotary spraying arms, of the hydraulic whirler type, are set in rotation by the thrust of at least one spraying jet ad always rotate in the same direction: the arrangement of the dishes in the baskets therefore leads, in relation to the shape of the dishes, to the formation of areas of shade, that is to say surface areas of the dishes which cannot be reached directly by the spraying jets.

A further limitation of known dishwashing machines is that the rotating spraying arms are provided with a fair number of spraying nozzles which, during the rotation of the arms, travel along predetermined spraying circumferences or "paths" generating discontinuous spraying cones so that the direct action of the jets on the surface of the dishes, even in the absence of areas of shade, is not complete.

To avoid this limitation, it would be necessary to increase the number of nozzles, the size of which cannot fall below certain limits, and therefore the flow rate required, with a consequent increase in the power of the pumps and of their size and of that of the recirculation pipes and ultimately in the volumetric capacity of the recirculation circuit.

These disadvantages are overcome by the dishwashing machine forming the subject of the present invention, which is provided with:

- at least one spraying device with rotating arms which form at least two manifolds which are separate and distinct but integral with one another, having a separate feed inlet in order to be fed separately with liquid, independently of one another, spraying and thrust nozzles being open in the two manifolds,

- and means for conveying a flow of liquid, selectively into one or the other of the two manifolds or into both.

According to a further feature of the present invention, the spraying nozzles which are open in one of the pipes are arranged at a radial distance from the axis of rotation of the device intermediate in relation to that of the spraying nozzles open in the other manifold so as to double the number of spraying paths.

According to a further feature of the present invention, the thrust nozzles open in the two manifolds are orientated so as to impart co-operating torques to the spraying device.

According to another feature of the present invention, the thrust nozzles open in the two manifolds are orientated in order to impart to the sprayer opposite torques so as to set the spraying device in rotation in one or the other of the two directions of rotation according to whether one or the other of the two manifolds is fed.

Advantageously, in this case, the thrust nozzles are dimensioned and/or arranged at a distance from the axis of rotation of the device and/or fed with fluid at different pressure in such a manner that the opposite torques which are generated in the case of combined feeding of the two pipes do not neutralize one another and the resulting torque sets the spraying device in rotation.

According to a further feature of the present invention, the dishwashing machine is provided with programming devices to order the combined feeding of the two manifolds during the prewashing and rinsing phases of a washing cycle, and the intermittent mutually exclusive feeding alternatively of one or the other manifold during the washing phase of a washing cycle.

The characteristics and the advantages of the invention will become clearer from the description which follows of a preferred embodiment and of its variants, which is given with reference to the attached drawings, in which:

- Figure 1 is a diagrammatic overall view in vertical section of a dishwashing machine made in accordance with the present invention.
- Figure 2 is a top view of a preferred embodiment of a spraying device for the machine shown in Fig. 1.
- Figure 3 is a view in section, along the section A-A in Fig. 1, of the spraying device.
- Figure 4 is a view in section, also along the section A-A in Fig. 1, of a second embodiment of the spraying device.
- Figure 5 shows in a qualitative diagram a number of curves which describe the functional characteristics of a pump for a dishwashing machine and the load curves of a spraying device such as that shown in Figures 2, 3 and 4.
- Figure 6 shows diagrammatically the action of the spraying jets on the dishes in a machine provided with a sprayer such as that shown in Fig. 4.

With reference to Figure 1, a dishwashing machine according to the invention comprises essentially a washing chamber 1 which ends at the bottom in a tank 2 for collecting liquid and in a basin 3 for containing a filter (not shown) and for conveying liquid to at least one recirculation or discharge pump 4.

The pump 4 is actuated by a motor 5, generally a synchronous motor, and has its outlet connected to the inlet of a diverting unit 6, for example of the rotating cylinder type, actuated by a motor member 7.

When open, a filling solenoid valve 8, with an inlet connected to the water mains, feeds liquid to the tank 2, if appropriate through a softening cell (not shown).

A level detector 9, for example of the pressure-switch type, sends a level signal to a programmer 10 which orders the activation of the solenoid valve 8, of the motor 5 and of the motor member 7 according to the various phases of a washing cycle.

In the known art, the diverter 6 diverts the flow generated by the pump 4 selectively in a mutually exclusive manner towards a first rotating spraying device 11, or lower rotor, a second rotating spraying device 12, or upper rotor, which are arranged in the washing chamber 1, or towards a discharge 13.

According to the present invention, the diverter 6 is modified in order to operate in a completely different manner which will be considered below, after the fundamental feature of the present invention has been explained.

According to the fundamental feature of the present invention, at least one of the spraying devices and preferably the lower rotor 11 consists of two spraying manifolds which are separate and distinct and can be fed individually.

The structure of the rotor 11 is illustrated in Figures 1, 2 and 3, in which it shown, respectively, in a composite vertical section (Fig. 1) along section B-B in Figure 3, in a top view (Fig. 2) and in horizontal section along the section marked A-A in Fig. 1 (Fig. 3).

The rotor consists of two rotating arms 14, 15 which are arranged symmetrically relative to an axis of rotation 16 and form two flow chambers or manifolds 17, 18 which are expediently separated by internal partitions 19, 20.

In the upper wall of the two arms, a plurality of N spraying mouths or nozzles 21, 22, 23, 24, 25, 26 are open which make the manifold 17 communicate with the outside.

Through the effect of the rotation of the arms about the axis of rotation 11, the nozzles travel along N concentric paths which are preferably but not necessarily equidistant.

The spacing between the paths is essentially equal to (D-d)/(N-1) where D is the diameter of the outermost path, d the diameter of the innermost path and N the number of nozzles.

At the ends of the arms 14, 15, the manifold 17 is provided with thrust nozzles 27, 28 for the ejection of two jets of liquid with a speed component which imparts

a torque to the arms, for example in the closckwise direction with reference to Figures 2 and 3, represented by the arrows 29, 30.

Also open in the upper wall of the rotating arms 14, 15 is a second plurality of spraying mouths or nozzles 31, 32, 33, 34, 35, 36 (in a number M preferably but not necessarily equal to N) which make the manifold 18 communicate with the outside and are arranged in such a manner that, through the effect of the rotation of the arms, these nozzles travel along paths which are intermediate in relation to those travelled along by the nozzles of the first plurality.

In this manner, the spacing between the various spraying paths is halved and the sprayed area is covered by the spraying jets with greater resolution.

The manifold 18 also is preferably provided at the ends of the arms with thrust nozzles 37, 38 for the ejection of two jets of liquid with a speed component which imparts a torque to the arms, for example in the same direction as that imparted by the jets emerging from the nozzles 27, 28.

Alternatively, as shown in Fig. 4, the two manifolds 17 and 18 can be provided with thrust nozzles 39, 40 and 41, 42 respectively for the ejection of jets of liquid which impart to the arms opposite torques which are shown respectively by the arrows 43, 44, preferably of different magnitudes, which can be achieved easily by different diameters of the thrust nozzles, by different pressures of the liquid which is made to flow out from the nozzles, by different distances of the nozzles from the axis of rotation, by different orientations of the nozzles in order to achieve different useful thrust components, or by a combination of these factors.

As can be seen clearly in Fig. 1 and in the sections in Figs 3 and 4, the rotor 11 formed by the arms 14, 15 is provided with a hub 45, in which is inserted a screw for fixing the rotor, with the function of an axis, to a support 46, in which two coaxial ducts 47, 48 are formed, which are open on the upper face of the support and communicate respectively with the manifold 18 through two openings 49, 50 of circular-segment shape, and with the manifold 17 through an opening 51 of circular-ring shape, which surrounds the hub 45, which openings are open in the lower wall of the rotor and face the coaxial ducts 47, 48.

The ducts 47, 48 of the support 46 are selectively made to communicate with the outlet of the pump 4 by means of the diverting device 6.

Expediently, the diverting device 6 can be designed to operate according to 4 angular positions of its rotating cylinder as follows:

1st position: outlet of the pump connected to duct 47 only.

2nd position: outlet of the pump connected to duct 47 and jointly to duct 48.

3rd position: outlet of the pump connected to duct 48 only.

4th position: outlet of the pump to discharge pipe 13 only.

The diverting device 6 can of course be replaced by other equivalent means, for example independent valve devices for closing/opening each flow path, or pumps which can be activated individually for feeding each flow path, although in this case only some and not all of the advantages afforded by the invention are achieved.

Before describing the various possible operating methods of a dishwashing machine such as that described, it is appropriate to consider with reference to Fig. 5 the characteristic curves of a pump employed in the dishwashing machine shown in Fig. 1 under different working conditions.

For reasons of cost and of constructional simplicity, the pumps used in dishwashing machines have a characteristic speed or characteristic number of revolutions $n_g = n\sqrt{Q}/H^{3/4}$ (where n = speed of rotation in revolutions/minute, Q = flow rate in m^3/s and H = head in metres) which is medium/high, greater than 100.

For this type of pump, with a constant speed of rotation, the head generated decreases greatly with an increase in the flow rate delivered and is shown by the curve H(Q).

The power consumed by the pump is shown by the curve P and initially increases for low flow rates, before decreasing rapidly as the flow rate increses.

The delivery is represented by the curve η.

The working point of the pump is defined by the intersection of the characteristic curve H(Q) with a load curve.

To a first approximation, since the function of the pump is to generate spraying jets, and ignoring therefore the head losses of the hydraulic circuit and static head between the level of the liquid in the basin 3 and the level of the spraying nozzles, the entire head of the pump is converted into kinetic energy, therefore speed of outflow from the nozzles.

The load curve is therefore represented to a good approximation by the equation $Q = S\sqrt{2gH}$ where S is the outflow section, corrected to take account of the contraction of the fluid stream.

The curve QL1 represents by way of indication the load curve for a section S1 equal to the cumulative outflow opening of the nozzles which are open towards the outside in the manifold 17, and corresponds qualitatively to an optimum state of use of the pump, corresponding to the maximum delivery and to the maximum power consumed.

It is clear that if the nozzles which are open in the manifold 18 have the same useful cross section, the curve QL1 represents the load curve for this group of nozzles also.

The cumulative load curve of the two groups of nozzles which are open in the manifolds 17 and 18 is given clearly by the sum, related to the axis of the flow rates, of the two load curves and is represented by the curve Q (L1 + L2) in Fig. 5.

It is clear therefore that if the nozzles of only mani-

fold 17 or of only manifold 18 are fed, the conditions of outflow from the working nozzles of the pump are defined by the point 149 whereas, if the nozzles of both manifolds are fed together, the outflow and working conditions are defined by the point 60.

In practice, the cumulative flow which results is much greater (as much as 50% greater) and the speed of outflow from the nozzles is lower (roughly 25%) with consequent halving of the power of the spraying jets and a significant reduction in the power consumed by the pump.

It is therefore possible to achieve a relatively high flow rate of the spraying jets with reduced jet power, which is particularly effective for carrying out prewashing and rinsing operations, without modifying the characteristic of the pump, for example by increasing its number of revolutions, which would produce an increase in the flow rate but would also bring about a more than proportional increase in the head and therefore in the power consumed.

If it is desirable, the joint feeding of the two manifolds 17, 18 can be combined with a slight increase in the speed of rotation of the pump.

Consequently, the characteristic curve of the pump is represented by the curve Q1(H), the power consumed by the curve P1 and the delivery by the curve $\eta 1$.

The working conditions are in this case represented by the point 150 and involve a power consumption which is approximately equal to that which occurs, at lower speed, when only one of the manifolds 17, 18 is fed.

Various possible methods of operation of a dishwashing machine according to the present invention, that is to say provided with a rotating sprayer with two selectively feedable spraying manifolds, will now be considered.

During a prewashing phase, the programmer 10 (Fig. 1) orders the feeding of both the manifolds 17 and 18 (Fig. 3).

These operations take place therefore with an increased flow rate Q2 (Fig. 5) and with a power of the spraying jets which is lower and correlated to the head H2 (Fig. 5).

The spraying jets are distributed on spraying paths which are very close together and the operations are particularly effective without the motor for actuating the pump being overloaded (even in a case where the flow rate is increased further to the value Q3 as the speed of rotation rises).

It is easy to check that, if the thrust nozzles are cooperating, the speed of rotation of the sprayer is higher than that imparted to the sprayer when only one manifold is fed.

If the thrust nozzles are antagonistic but the torques generated do not neutralize one another, the speed of rotation of the sprayer is lower.

The flow rate of liquid which strikes the sprayed surface is the same in both cases and the effectiveness of prewashing and rinsing is the same, with a certain advantage in the second case because each point of the sprayed surface received pulses of spraying liquid of longer duration although at lower frequency.

When the prewashing phase has been carried out, a washing phase is ordered, in which only one of the manifolds of the rotor is fed.

The washing phase is then carried out with a reduced flow rate Q1 (Fig. 5) but with the power of the jets correlated to a high head H1 which is therefore suitable for disincrusting tenacious dirt with an effective mechanical action.

As a possible and preferable alternative, the washing phase can be divided into two or more sub-phases, during which one or other of the manifolds 17, 18 is fed alternatively in a mutually exclusive manner.

In this manner, the spraying jets of the two manifolds, which travel along different spraying paths, strike the surfaces to be washed with double the resolution.

Two cases can be distinguished:

in a case in which the thrust nozzles of the two manifolds exert a torque in the same direction on the rotating sprayer, it rotates in the various sub-phases, always in the same direction, and possibly at different speeds.

The combination of the rotary speed of the sprayer with the outflow speed of the jets from the nozzles, which is generally directed in the same direction as the axis of rotation, imparts to the jets a transverse component (which increases with the distance of the jets from the axis of rotation).

If the speed of rotation in the various sub-phases is different, as can easily be achieved by the dimensioning, positioning and orientation of the thrust nozzles, the transverse component is different in the various sub-phases and, in addition to increased resolution in washing, it is possible to exert mechanical stresses which act in different directions and to make it possible for the jets to force themselves in between adjacent walls of articles to be washed, striking directly, in one of the sub-phases, surface points which in another sub-phase are sprayed indirectly by reflection of the jets because they are concealed from direct exposure by the presence of other dishes.

This effect, which is diagrammatically represented in Fig. 6, is intensified in a case in which the thrust nozzles exert opposed torques on the sprayer: in Fig. 6, two plates 51, 52 to be washed, arranged vertically in a washing basket (not shown), are sprayed by jets G1 during a first washing sub-phase and by jets G2 during a second sub-phase.

The jets G1 act effectively on the internal face of the plates and the jets G2 act effectively in a direct manner on the external face.

The number of useful reflections is also increased.

For example, the reflected jet G1R makes it possible to spray a zone of the plate which cannot be sprayed directly by the jets G1 and G2 and the reflected jet G2R makes it possible to spray a zone of the plate 52 which cannot be sprayed directly by the jets G1, G2 or by reflection of the jet G1.

When the washing phase has been carried out, the washing liquid in the basin 3 is discharged in response to a command from the programmer 10 (Fig. 1) and replaced with rinsing water.

The rinsing phase can then be carried out with a high spraying flow rate which is obtained by feeding simultaneously the two manifolds as in the prewashing case.

The operation is therefore effected effectively in a very short time with a clear saving in consumption.

In the description above, reference has been made to a single spraying device 11 formed by two separate manifolds which are individually and selectively fed by a flow of liquid.

It is clear, however, that the same concepts can also be applied in the case of dish washing machines provided with two spraying devices, for spraying dishes accommodated in a lower basket and dishes accommodated in an upper basket respectively.

For example, in Fig. 1 an upper spraying device 12 is shown, which can have a structure which is identical to that of the sprayer 11.

For feeding it with two flows of liquid, which are admitted selectively into the manifolds, the support 46 is provided with two connections 53, 54 which connect the ducts for supplying liquid 47, 48 respectively, by means of pipes 55, 56 and an upper support (not shown) for the rotating sprayer, to the sprayer 12.

In this way, the upper sprayer 12 is connected in parallel, in the various phases of the washing cycle, with the lower sprayer 11.

It is clear, however, that the upper sprayer 12 can be provided with an independent feed circuit fed by its own pump, as well as with a feed circuit which has a pump for common delivery for the two sprayers but is provided with valve devices for shutting off and diverting the flow for its feed independently of that of the lower sprayer, in such a manner that, for example, the operations of prewashing and rinsing are carried out by feeding jointly both the manifolds of the two sprayers, and the operation of washing by feeding selectively, one at a time or in a suitable combination, according to the degree of soiling, the various manifolds of the two sprayers.

The description above relates only to a preferred embodiment of a dishwashing machine with rotating sprayers with a number of liquid manifolds.

It is clear, however, that various modifications can be effected without departing from the scope of the invention.

For example, the sprayers, instead of being formed by a pair of rotating arms in which the two manifolds are formed, can also be constituted by more than two rotating arms in any number N.

Moreover, if the number N of arms is even, and preferably greater than or equal to 4 (for reasons of balancing the thrust of the nozzles), the two manifolds can be made in one half and in the other half of the number of arms respectively.

The number of manifolds can also be greater than two to achieve even greater operating versatility.

Claims

1. Dishwashing machine with at least a first rotating sprayer (11) set in rotation by the hydrodynamic thrust of the jet leaving at least one nozzle (29, 30), characterized in that said sprayer (11) comprises at least two separate and distinct manifolds (17, 18), each provided with a plurality of spraying nozzles (21, .. 26, 31, .. 36), and in that said dishwashing machine comprises means (4, 6) for feeding in an exclusive manner at least one of said manifolds (17, 18) with a flow of spraying liquid.

2. Dishwashing machine according to Claim 1, comprising means (4, 6) for feeding in a mutually exclusive manner each of said manifolds (17, 18) with a flow of spraying liquid.

3. Dishwashing machine according to Claim 1 or 2, comprising means (4, 6, 5, 7, 10) for feeding said manifolds (17, 18) together during a rinsing and/or prewashing phase of a washing cycle.

4. Dishwashing machine according to Claim 1, 2 or 3, in which nozzles (22, 23, 24, 25) of one (17) of said manifolds are open in said manifold (17) at distances from the axis of rotation of said rotating sprayer which are intermediate in relation to the distances from the axis of rotation at which the nozzles (31, 32, 33, 34, 35, 36) of the other (18) of said manifolds are open.

5. Dishwashing machine according to Claim 1, 2, 3 or 4, in which the flow of spraying liquid which feeds one or the other of said manifolds (17, 18) sets said sprayer in rotation in the same direction.

6. Dishwashing machine according to Claim 1, 2, 3 or 4, in which the flow of spraying liquid which feeds one of said manifolds (17, 18) sets said sprayer in rotation in a first direction at a first speed of rotation, and the flow of spraying liquid which feeds the other of said manifolds sets said sprayer in rotation in the opposite direction to said first direction, at a second speed of rotation which is different from said first speed, in such a manner that the flow of spraying liquid which feeds said manifolds together sets said sprayer in rotation at a third speed.

7. Dishwashing machine according to the preceding claims, in which said feeding means (4, 6) comprise a first pump (4) and a second pump, which pumps can be actuated independently in order to feed said first and second manifolds respectively.

8. Dishwashing machine according to Claim 1, 2, 3, 4,

5 or 6, in which said feeding means (4, 6) comprise a pump (4) and valve means (6) for feeding selectively said manifolds with a flow of liquid generated by said pump (4).

9. Dishwashing machine according to Claim 8, comprising a variable-speed motor (5) for actuating said pump (4), and means (10) for controlling the speed of said motor (5) in order to order greater speed of said motor when said valve means (6) feed said first (17) and second (18) manifolds together.

10. Dishwashing machine according to the preceding claims, comprising a second rotating sprayer (12) which has at least two separate and distinct manifolds, each provided with a plurality of spraying nozzles and means (4, 6) for feeding together, with a flow of spraying liquid, a manifold of said first sprayer (11) and a manifold of said second sprayer (12).

11. Dishwashing machine according to one of Claims 1 to 9, comprising a second rotating sprayer (12) comprising at least two separate and distinct manifolds, each provided with a plurality of spraying nozzles and means for feeding selectively, with a flow of spraying liquid, said manifolds of the second sprayer (12) independently of the feed of the manifolds (17, 18) of said first sprayer (11).

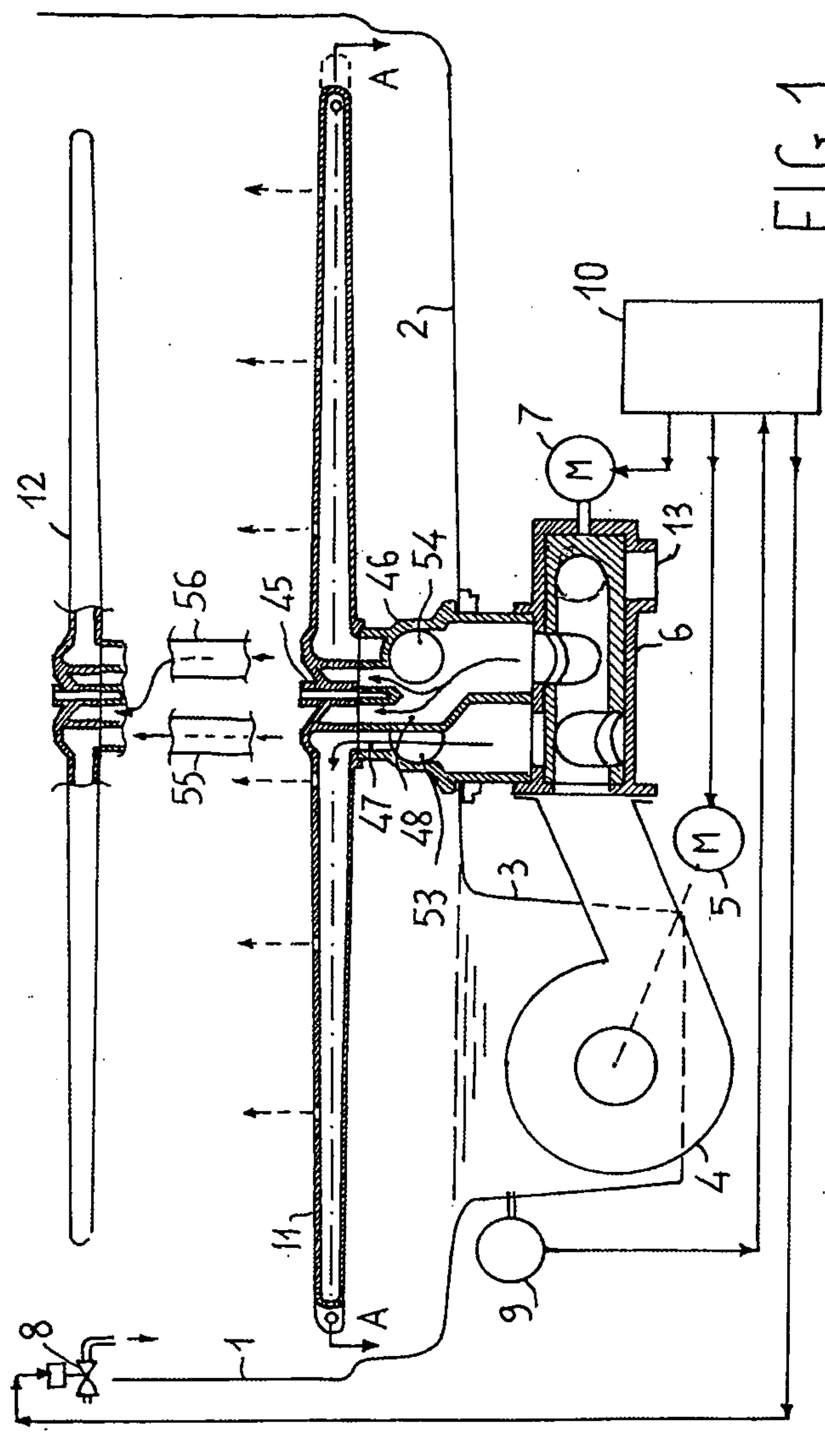


FIG. 1

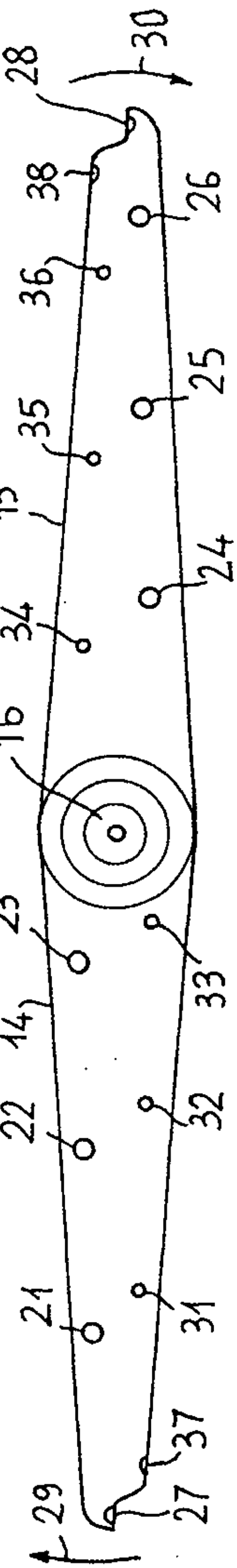


FIG.2

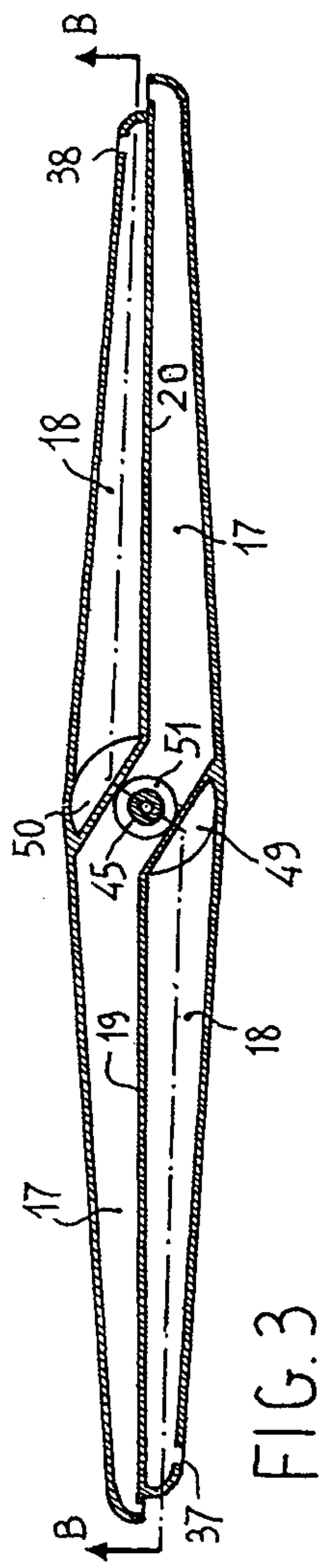


FIG.3

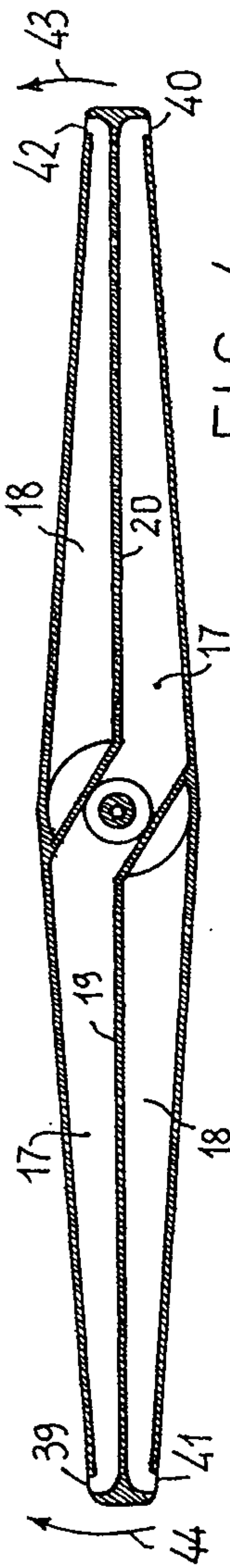
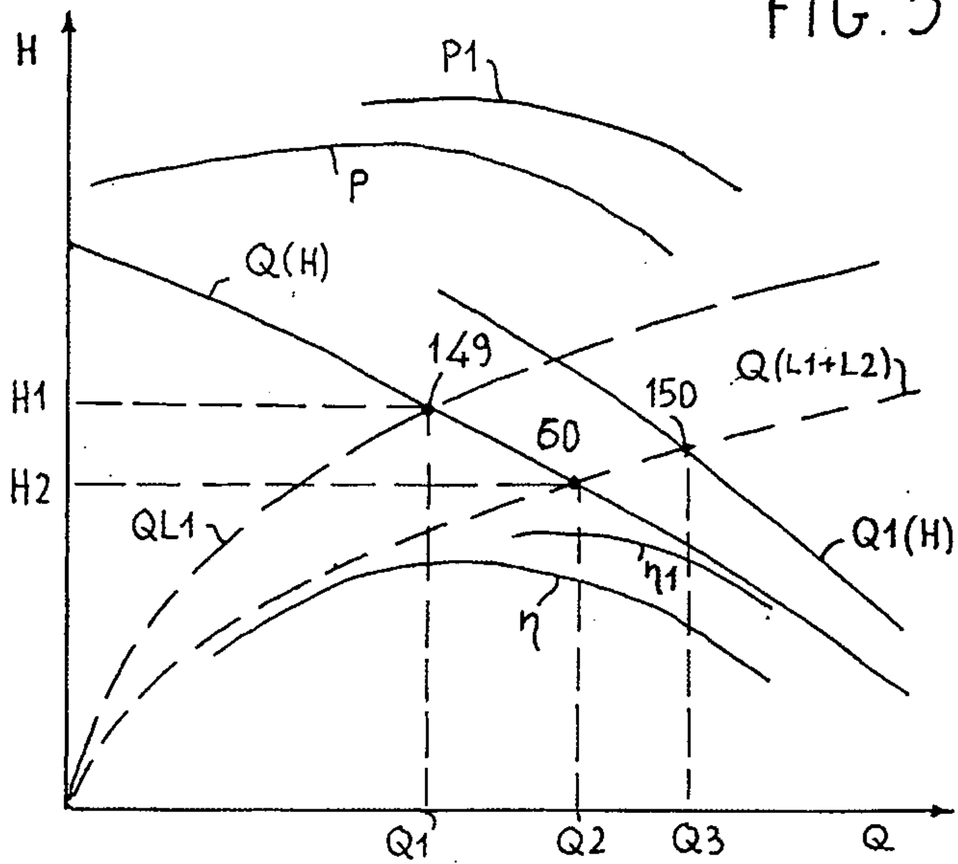


FIG.4

FIG. 5


H
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P
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Q(L1+L2)
H1
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H2
QL1
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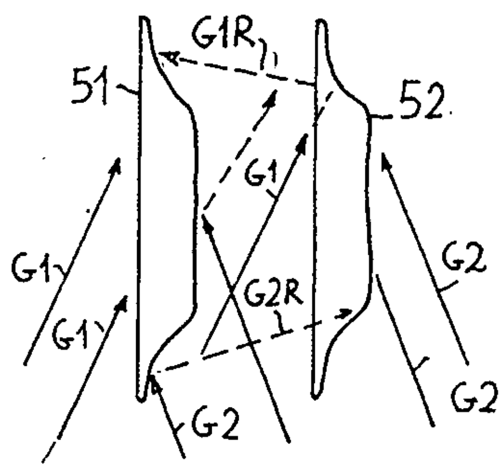
η1
η
Q1
Q2
Q3
Q


G1R
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52
G1
G1
G1
G2R
G2
G2
G2

FIG. 6